

we have an opening in the chest wall, the size of which we can increase or diminish at pleasure.

We will, then, first consider the case when the wound is large and free, so free that the air may pass through it in either direction without any obstruction. In this case, unless prevented by adhesions, or by a condition to which I shall advert hereafter, the lung contracts as completely as it would do if it were removed from the chest. But this complete contraction continues only during inspiration. With every expiratory act the lung is slightly inflated. This is owing to the fact that the glottis is not sufficiently large to allow perfectly free exit to the air from the lung on the uninjured side. A portion of this air is therefore forced through the bronchial connections into the opposite lung, which is perfectly free to expand, since the air by which it is surrounded has easy egress from the chest.

Indeed, were it not for the elasticity of the lung, the quantity of air which would enter it would be to the quantity actually exhaled as the area of its bronchus to the area of the glottis.

I have here a mechanical contrivance designed to illustrate the effect upon respiration resulting from wounds of the chest of different sizes. It consists of two bellows, placed side by side, representing the two cavities of the chest, and made to move simultaneously by means of a handle which is common to both. Connected with each bellows is a tube representing the bronchus; the two tubes merging into one which answers to the trachea. Each bellows has a rubber bag within it representing the lung and communicating with the bronchus. The movements of the bags are exposed to view by means of plates of glass set in the tops of the bellows. Each bellows is provided also with an opening designed to represent a wound of the chest-wall, and which may be partly or wholly closed by means of a slide.

On withdrawing the slide of one bellows entirely and detaching the tube by which this bellows is connected with the other, it will be seen that the movements of the handle have no effect whatever upon the bag. But upon replacing the tube you perceive that each time the handle is depressed the bag is partially inflated with air driven from the other bellows.

When the respiration is quiet and regular, the expansion of the collapsed lung with each expira-

tion is comparatively slight; but when the expiratory movement is more forcible and at the same time the glottis is partially closed, a very large portion of the air from the sound lung may be forced into the one collapsed; and two or three such expirations, in rapid succession, may be enough to distend it completely and even to force a portion of it out through the wound, producing hernia of the lung. These points are illustrated in the following experiment:

A large dog was placed completely under the influence of chloroform and an opening three inches in length made in the ninth intercostal space on the left side. The lung immediately collapsed, but could be seen to expand slightly with each expiration, subsiding again with each inspiration. As the effect of the chloroform passed off, and consciousness began to return, there was an attempt at a vocal expression of suffering with each expiratory act. This caused a decided increase of the distention of the lung. The wound being closed with the fingers, this vocal effort resulted in a faint moan, which ceased immediately when the wound was uncovered. On introducing an instrument into the back of the neck, with intention of breaking up the medulla oblongata, loud cries were uttered and the lung immediately filled the chest and protuded from the wound.

It is to be remarked that, in this experiment, moderate efforts at phonation were ineffectual so long as the wound remained open. This was, no doubt, owing to the large amount of air which passed from the lung on the uninjured side into the other lung, not leaving enough to pass through the glottis to cause vibration of the vocal chords. But the moment the wound was closed the air imprisoned in the pleural cavity prevented the expansion of the crippled lung, compelling the entire quantity of air from the sound lung to pass out through the glottis, and phonation was the result.

The extreme pain from the introduction of the instrument caused an extraordinary vocal effort, involving a violent expulsion of the air from the sound lung and at the same time a further diminution of the opening of the glottis, both of which circumstances contributed to the expansion of the collapsed lung.

Similar observations have been recorded by various writers, whose explanations are substantially that which I have given. But they all seem to